A Multi-dimension Correlational Study Between Self-Directed Learning and Team Effectiveness in Project-Based Learning

Low Bee Lee, School of Chemical and Life Sciences – Singapore Polytechnic, Singapore
Desmond Ng, School of Chemical and Life Sciences – Singapore Polytechnic, Singapore
Heng Jun Jie, School of Chemical and Life Sciences – Singapore Polytechnic, Singapore
Low Kang Min, School of Chemical and Life Sciences – Singapore Polytechnic, Singapore

The Southeast Asian Conference on Education 2024
Official Conference Proceedings

Abstract
At Singapore Polytechnic (SP), the Diploma in Perfumery and Cosmetic (DPCS) embraces an innovative Industry Now Curriculum (INC) pathway. With this framework, students engage in industry projects to equip themselves with valuable knowledge and skills crucial to the profession. This project-based learning (PBL) approach not only imparts practical expertise but also fosters autonomous learning through collaborative team-based activities. Students are empowered to solve complex real-world problems by capitalising on concerted team efforts and self-directed learning skillsets inculcated in the learning process. This study was designed to investigate the plausible effect of team effectiveness (TE) on students' self-directed learning readiness (SDLR). The results, based on Friedman test with a significance level of $p < 0.001$, revealed a notable increase in SDLR as project teams deepened their engagement in PBL over time. Deeper insights into the relationships between TE and SDLR were corroborated by strong Spearman correlations ($\rho > 0.8$) and qualitative teamwork evaluations. The findings concluded that specific team factors of Team Motivation, Team Structure, Team Dynamics, and Team Excellence exhibited positive and consistent associations with enhanced SDLR. Harnessing this synergy derived from TE in the cocreation of a collaborative, inclusive, and supportive learning environment, in conjunction with students' sustained interest in independent problem solving and skill development through PBL, would redefine the way we perceive self-directed learning. The ability to take ownership of learning under team influence would transform the concept of an individual playing the central role in the agency of learning to stimulate personal growth.

Keywords: Industry Now Curriculum, Design-Thinking, Project-Based Learning, Team Effectiveness, Self-Directed Learning Readiness

Introduction

The mission of Singapore Polytechnic is to provide a holistic education for the development of six graduate attributes, including (i) Competency & Versatility; (ii) Communication & Collaboration; (iii) Creativity, Innovation & Enterprise; (iv) Ethics & Responsible Citizenry; (v) Self-Directed & Personal Effectiveness and (vi) Global Mindset. Self-Directed Learning (SDL), in particular, is crucial for lifelong learning in the dynamic education and VUCA industry landscape.

By referencing to Malcom Knowles's (1975) definition of self-directed learning as follows:

> *In its broadest meaning, SDL describes a process in which individuals take the initiative, with or without the help of others, in diagnosing their learning needs, formulating learning goals, identifying resources for learning, choosing and implementing appropriate learning strategies, and evaluating learning outcomes.*

This initiative aims to cultivate SDL based on team influences.

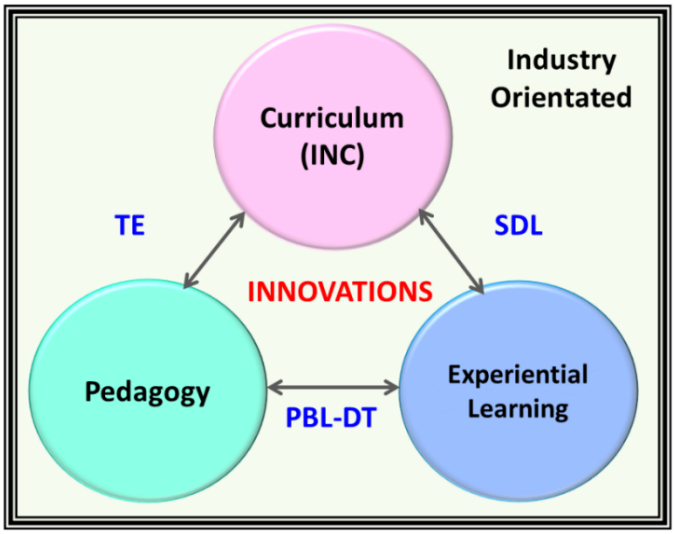


Figure 1: Macro-representation of the pivotal roles of INC, PBL-DT and Team-SDLR approach in driving innovations under industry settings.

Figure 1 illustrates macro-representation of the pivotal roles of INC, PBL-DT and Team-SDLR approach in driving innovations under industry settings. Together with the integration of theoretical and practical learning experiences, specific learning outcomes in response to future skills demands have been achieved in INC. The learning contents and assessments are designed with inputs from industry experts in order to align with the current trends, technologies, needs, standards and practices of the industry. The INC provides a structured way to incorporate experiential learning activities into industry-sponsored projects, internship and mentorship programs. In this way, students are presented with learning and networking opportunities to acquire relevant technical knowledge and skills as well as develop professional portfolios for enhanced employability. The experiential learning is facilitated through PBL-Design Thinking (DT) pedagogy as students work collaboratively on industry-sponsored projects that mirror industry scenario. In order to create tangible innovations for the industry collaborators, each project team are required to take ownership in active upskilling, continual experimentation and critical reflection in search of the feasible solutions to the project challenges.

Research Questions

It is of great interest to address the following research questions:

1. What are the team factors that would influence self-directedness/autonomy?
2. How does the INC instructional design develop TE through project-based learning?
3. What co-relationships exist between SDL behaviours and TE?

The conceptual framework is further elaborated in Figure 2. INC provides the platform to empower students in planning and executing the learning outcomes while integrates the application of PBL-DT pedagogy to co-create innovations for solving authentic and complex real-world issues. The implementation of the detailed instructional design in TE development would address Research Question 2. On the other hand, Research Question 1 would be addressed by the pillars of team effectiveness in terms of motivation, structure, dynamics and excellence. The plausible effect of these team factors on SDLR are further investigated to address Research Question 3.

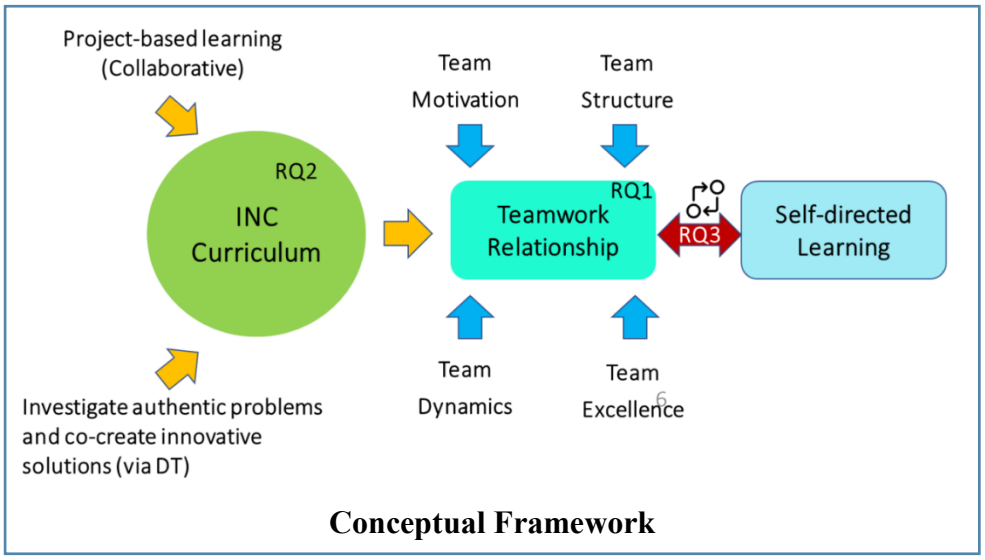


Figure 2: Conceptual framework for study of SDL, TE and its team factors to facilitate PBL-DT in INC.

Literature Review

SDL, a critical skill of 21st century, has undergone transformative evolution over time. This is marked by shifts in educational philosophies, advancements in science and technology, and changing perspectives on the role of learners in shaping their own educational experiences. The SDL evolution has since been influenced by many theorists, psychologists, and educators. The SDL concept first gained significant traction in the mid-20th century when Malcolm Knowles (1968) coined the term 'andragogy' of adult learning. While not exclusively focused on SDL, Carl Rogers (1969) emphasized the importance of a supportive and non-judgmental learning environment that fosters self-directed exploration and intrinsic motivation in learner-centred education. Paulo Freire (1968) also posited that dialogue, critical consciousness and transformative learning in critical pedagogy have influenced SDL discussions to extend beyond individual development to include social and emancipatory dimensions. Albert Bandura (1977) and Lev Vygotsky (1978) posited the importance of social learning theory and social-cultural theory on SDL. The late 20th century witnessed the emergence of Katherine Wiley (1983), David Boud (1985), Stephen Brookfield (1985), Jack Mezirow (1985), Huey B. Long (1989), Philip Candy (1991), Jean Lave and Etienne

Wenger (1991), and Randy Garrison (1997). At its core, Wiley (1983) stressed the importance of self-regulation and autonomy in learner's ability to set goals, identify resources, and monitor progress independently while Boud et al. (1985), Brookefield (1985) and Mezirow (1985) explored reflective practices in fostering autonomy in educational settings. While Long (1989) studied the roles of intrinsic motivation and self-efficacy in SDL, Candy (1991) delved into the cognitive and affective aspects of independent learning. Lave and Wenger (1991) continued the work on Communities of Practice. Garrison (1997) integrated contextual control, cognitive responsibility and motivational dimensions in SDL. As the 21st century witnessed the rise of internet, online courses and educational platforms, the unprecedented access to information, resources, and collaborative tools led to the introduction of connectivism concept by George Siemens (2004) and personalized learning by Kurt VanLehn, (2011) in fostering SDL. However, the dynamic landscape of education also led to in a plethora of theories about SDL manifestations in diverse contexts (Sharan Merriam, 2001; Michael Gibbons, 2002; Barry Vann, 2006). Ronald Hiemstra and Ralph Brockett (2012) reframed SDL into three aspects of personal responsibility, encouraging positive learning behaviours, and cultivating supportive learning environments. Stefanie Boyer et al. (2014) also studied the positive influence of internal locus of control, motivation, performance, self-efficacy, and support in SDL. Apart from internal factors, external factors play an equally important role in shaping SDL experiences. Betty Breed (2016) investigated the positive influence of effective cooperative learning, including learning positive interdependence, individual accountability, promotive face-to-face interactions, appropriate social skills and group processing on students' SDL. In more recent studies, Morris (2019) discusses the societal and individual factors on SDL promotion. Wong (2020) provides insights into how the interactivity within the small-group work can effectively motivate students to commit in developing cognitive skills for lifelong learning. Oyelere at al. (2021) further afformed the positive impact of self-regulated learning and teamwork experiences in academic performance. Subsequently, Tamara et al. (2021) and Kemp et al. (2022) also explored the contribution of collaborative efforts towards SDL.

Methodology

Thirty-nine year two DPCS cohort (n= 39) participated in this study who are distributed into nine groups of four and one group of three (n^{group} =10). Three sets of questionnaires were prepared. The first questionnaire was adopted from the well-validated Fisher's SDLR Scale (Fisher et al., 2001; Torabi et al., 2013; Kumar et al., 2021; Laine et al., 2021) which comprises of 40 items that are subdivided into the three domains: Self-Management, SM (13 items), Desire to Learn, DL (12 items) and Self-Control, SC (15 items). Questionnaire items were set up in Microsoft Forms. The survey comprises of scoring statements using a five-point Likert scale (1-Strongly Disagree; 2-Disagree; 3-Neutral; 4-Agree; 5-Strongly Agree). Monitoring of the SDLR development in students took place at three checkpoints with repeated measures at the beginning (baseline), middle and end of the semester. The second questionnaire, comprises of 25 selected questions, was adapted from the Team Effectiveness Diagnostic, developed by London Leadership Academy, National Health Service. This aspect of the study is to solicit information to address Research Question no. 1, which evolves around four TE variables of interest, namely Team Motivation, Team Structure, Team Dynamics and Team Excellence with the objective to assess the effectiveness of the team's attributes and behaviours after going through the intervention process. Questionnaire items include scoring statements using the five-point Likert scale as before. The survey data was collected only after extensive team interactions had resulted (i.e., at the end of the semester) to give a more realistic assessment. Finally, the third instrument with nine items, also known

as Self & Peer Assessment (SPA), is customized with a five-point Likert scale. This monitoring tool not only serves as a feedback mechanism to help students improve on their teamwork performance but also aids in validating the consistency of TE outcomes. It was administrated on the Learning Activity Management System (LAMS) during the middle and end of semester. The profiling of teamwork performance is important so that the respective project supervisors can provide timely interventions and support individual's development within the team.

PBL-DT Pedagogical Approach

The integration of PBL-DT pedagogical approach (Maknuunah et al., 2021) creates valuable synergy to inspire product innovations. Figure 3 illustrates the schematic diagram of the PBL-DT implementation in a team setting. To address Research Question 2, specifically designed team activities and monitoring mechanisms are infused to support TE facilitation towards project completion.

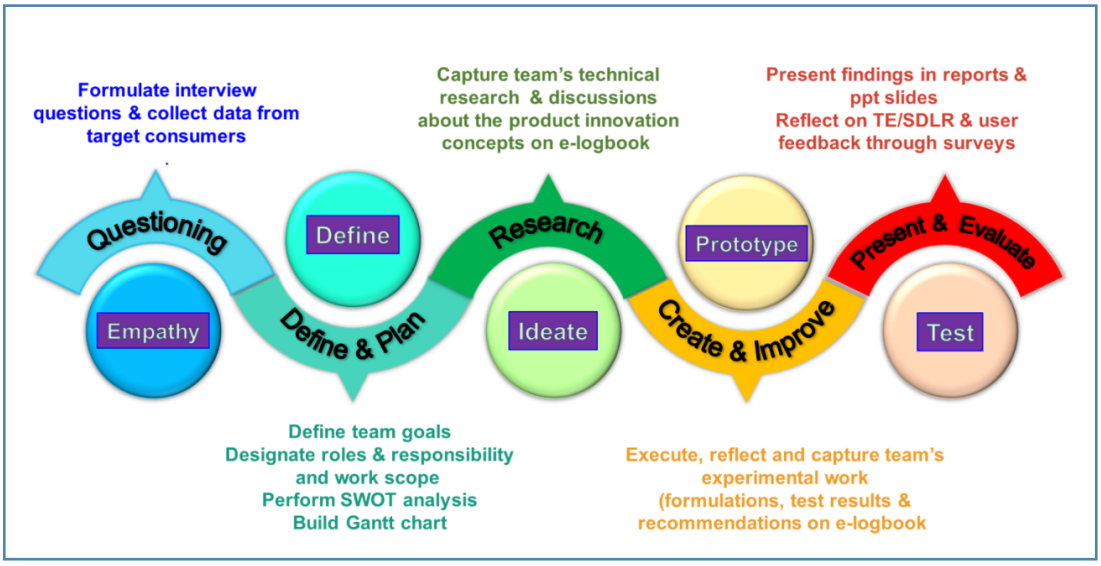


Figure 3: Schematic diagram of the PBL-DT implementation in a team setting.

The user-centric DT framework constitutes five phases to reframe and tackle wicked problems in a non-linear and iterative manner. The first stage of 'Empathy' provides students with an empathetic understanding of the behaviour and needs of users. The second stage of 'Define', helps students reframe the problem statements and personas after gathering sufficient consumer insights. The third stage of 'Ideate' ignites students' creativity to think out of the box and generate all possibilities and opportunities for the innovations. The fourth stage of 'Prototype' involves translating the most feasible and creative solution into a physical product so that evaluation of the product attributes can take place to cater to user needs in the final stage of 'Test'. The process may be iterative until product refinements are able to meet the project success criteria. Having said that, PBL instructional approach engages students to develop transferable skills of problem-solving, decision making and investigative abilities in addition to acquisition of relevant technical knowledge and skills. Furthermore, it encourages collaboration and cultivates students' sense of ownership. PBL synergizes the five DT stages, starting with the deployment of inquiry-based technique to stimulate intrinsic curiosity and solve problem statements. Team members would brainstorm and formulate interview questions to solicit consumer insights. These information helps teams to strategically define project scopes, milestones and plans. Project planning would

involve designation of roles and responsibilities, setting SMART (i.e., Specific, Measurable, Achievable, Relevant and Time-Bound) team goals, scheduling milestones, analysing SWOT to capitalise on its strengths and opportunities while preventing its weaknesses and threats from hindering project progress. Teams would then facilitate ideation of all possible innovative concepts and research for relevant technical information and resources from books, journals, lecture notes, articles, online materials etc.. The subsequent stage of create and improve is for prototyping the most feasible product concept which involves hands-on team activities such as experimenting on formulations, testing, data collection and other related laboratory work. Collaboration and communication skills are often emphasized since teams are given the flexibility to optimise its resource utilisation and make necessary recommendations for improving product formulations in an efficient and effective manner. At this stage, it is essential to monitor the project progress closely by tracking the tasks executed by every member, ensuring availability of materials and resources, evaluating findings as well as facilitating team priority and shared decision-making in a systematic manner. Details of the planning, monitoring and reviewing stages, including ongoing project direction, timelines, experimental formulations, results and recommendations, can be updated in e-logbook accordingly. The final stage of present and evaluate the outcomes would also involve collaborative efforts when facilitating insightful reflections and knowledge sharing. Teams would crystallize research findings and recommendations in the form of group reports and presentations to an audience comprising lecturers, industry partners and professionals in the field. Teams would also reflect on diagnostic feedback or self-assessments on teamwork performance and SDLR in their learning journey.

Results and Discussions

This study creates a meaningful purpose of harnessing the value of TE for reinforcing SDL due to limited correlation studies in a PBL environment. Firstly, the two principal latent (unobservable) factors of this hypothesis are verified using factor analysis of Minitab statistical software. As seen in Table 1, the high positive factor loadings (with acceptable criteria > 0.6) indicates a strong influence of the variables on each latent factor: TE (Team Motivation, Team Structure, Team Dynamics and Team Excellence) and SDLR (SM, DL and SC) respectively. The loading plot in Figure 4 illustrates the clustering of variables with respect to each latent factor. As a whole, TE and SDLR account for 95.1% (i.e., 0.951) of the variation in the data.

Variable	TE	SDLR	Communality
Team Excellence	**0.845**	0.497	0.961
Team Motivation	**0.838**	0.498	0.950
Team Structure	**0.884**	0.392	0.935
Team Dynamics	**0.914**	0.407	1.000
SM	0.563	**0.777**	0.920
DL	0.381	**0.899**	0.953
SC	0.429	**0.870**	0.942
Variance	3.6781	2.9824	6.6605
Var	0.525	0.426	**0.951**

Table 1: Rotated factor loadings and communalities data in factor analysis (n group =10).

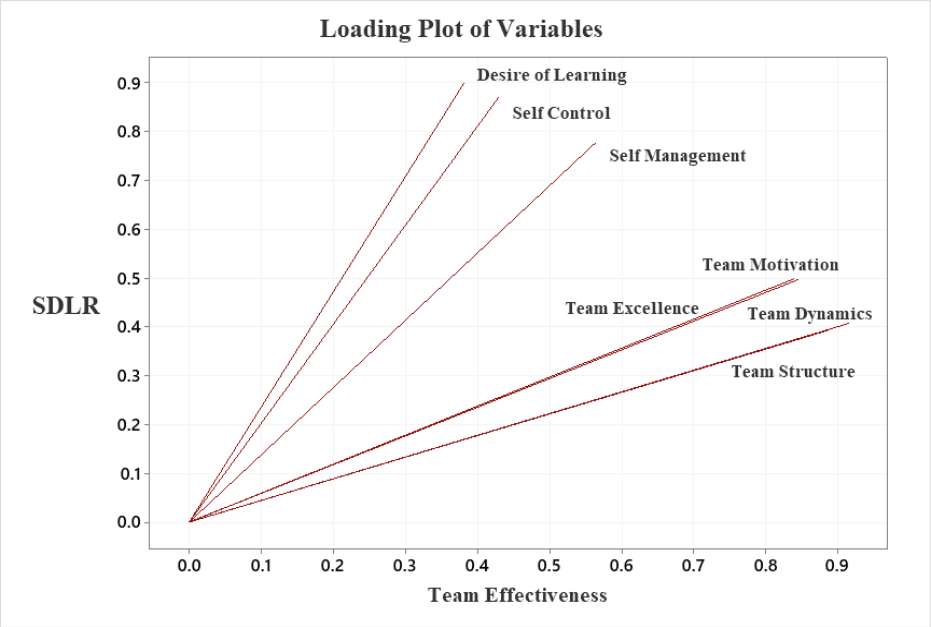


Figure 4: Loading plot of variables (n^{group} =10) for the principal latent factors, TE and SDLR.

The measurement constructs are further analysed using Cronbach's alpha (α). Good internal consistency is observed from Table 2. The reliability is considerably high since all α coefficients scores above 0.9 (with acceptable criterion of 0.7).

Cronbach's alpha, α	**(*n*=39)**
SDLR Construct	0.9360
TE Construct	0.9755
SPA Construct	0.9872

Table 2: Cronbach's alpha results for the three measurements of constructs (n = 39).

The SDLR construct is first discussed. As the validated SDLR Scale measures the extent an individual is willing to take up the responsibility for one's learning, it describes the degree at which the individual possesses the attitudes, abilities and personality characteristics necessary for SDL. It would imply the learners have the autonomy to plan, manage and control of their learning trajectories within the polytechnic. As such, SM subscale on managing the learning environment (e.g., time and resources); DL subscale on learner's motivation and attitudes toward learning and SC subscale on goal setting and self-monitoring/evaluation shall form the basis of the SDLR Scale (ranging from 40 to 200). If the total score exceeds 150, a high degree of SDLR is exhibited. Figure 5 captures a progressive SDLR enhancement in students across three checkpoints (i.e., from beginning, middle to end of semester) transiting from a lower baseline score (<150) to upgraded scores (> 150). Statistical differences in the median scores of SDLR subscales was determined with Friedman test at $p < 0.001$. The increment in SM and DL subscales is more noticeable initially while that of SC subscale occurs towards the end of the learning experience. A possible explanation could be students tend to focus more on planning and consolidating prior knowledge needed for fulfilment of project directives at the beginning. They become in a better position to control their learning needs and accomplish assigned tasks after gaining adequate confidence and competency over time.

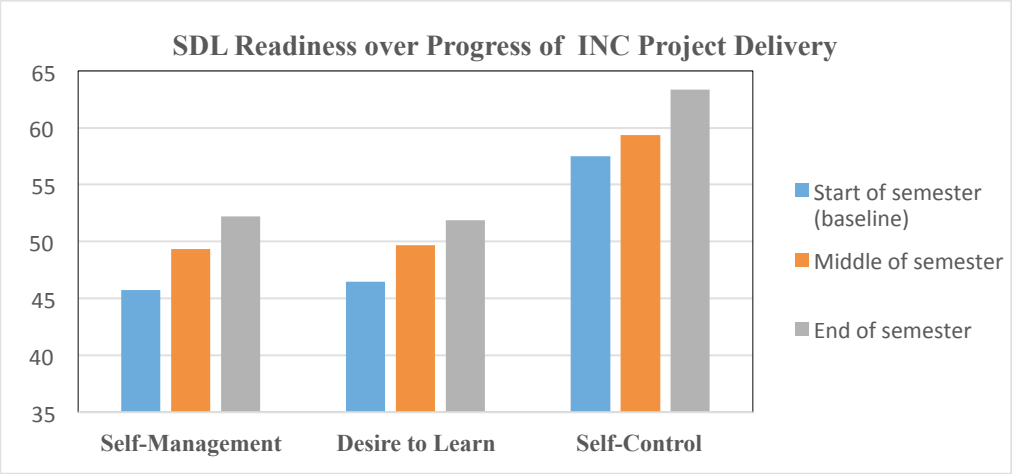


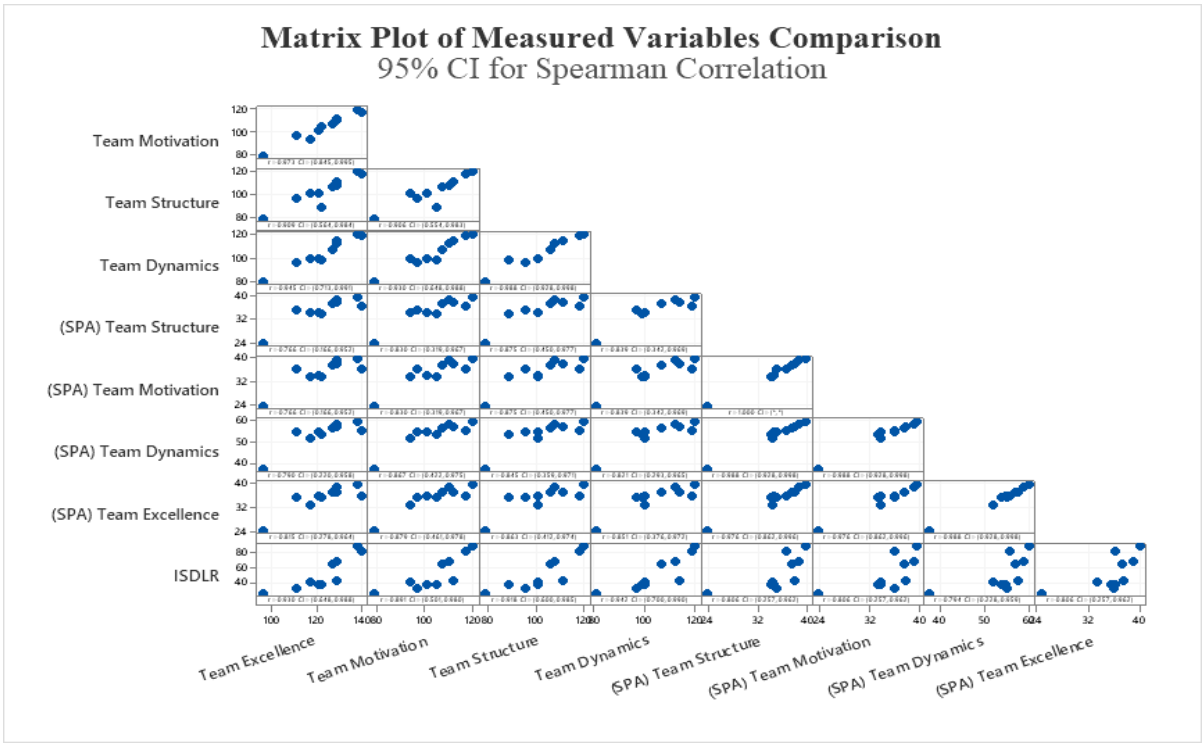
Figure 5: Progressive enhancement of SDLR measures (n = 39).

One the other hand, the core TE elements are morphed from GRPI model. This is one of the oldest and fundamental frameworks (Rubin et. al, 1978; Jaiswal et. al, 2021; Thabo et. al, 2021), comprising of four key elements: Goals, Roles, Processes, and Interpersonal Relationships, starting with team goal to augment a shared purpose, followed by the delegation of clear roles and responsibilities of team members to enable efficient work processes, including workflow, procedures, decision-making and conflict resolution. The readjustment of roles may be required for a more effective facilitation wherever possible. In this study, Team Motivation is chosen to incorporate purpose and team goals, Team Structure integrates the roles and processes while Team Dynamics encompasses effective team interactions. As individuals work together collaboratively, the team build trust and emotional security through strengthening of team's interpersonal relationships. Finally, Team Excellence encapsulates the mind-set on team–enabling growth orientation. A series of Spearman correlation coefficients (ρ) are compiled in Table 3 for the purpose of addressing Research Question 3.

Pairwise Spearman Correlations, *p*		**By groups (n^{group} = 10)**	**By cohort (*n* = 39)**
Team Structure	Team Motivation	0.906	0.893
Team Structure	Team Excellence	0.909	0.885
Team Motivation	Team Excellence	0.973	0.846
Team Dynamics	Team Motivation	0.930	0.848
Team Dynamics	Team Structure	0.988	0.914
Team Dynamics	Team Excellence	0.945	0.849
(SPA) Team Structure	Team Structure	0.875	
(SPA) Team Excellence	Team Excellence	0.815	
(SPA) Team Motivation	Team Motivation	0.830	
(SPA) Team Dynamics	Team Dynamics	0.821	
ISDLR	Team Excellence	0.930	
ISDLR	Team Motivation	0.891	
ISDLR	Team Structure	0.918	
ISDLR	Team Dynamics	0.942	

Table 3: The pairwise Spearman correlation of measured variables (n^{group} =10 and n = 39).

Apart from having both sets of ρ coefficients (either by group or by cohort) above 0.8, Figure 6 (a) illustrates a general upward trend in the corresponding matrix plots. Positive monotonic relationships among the measured variables: Team Motivation, Team Structure, Team Dynamics, Team Excellence and increased value of SDLR (ISDLR) are therefore inferred. Based on the acceptable ρ values for TE and SPA measures, SPA can serve as an independent instrument to countercheck the consistency of teamwork data. This concise version offers ease of periodic data collections so that timely interventions can be delivered. Similar trend on ISDLR vs TE (by group) is observed in Figure 6 (b).



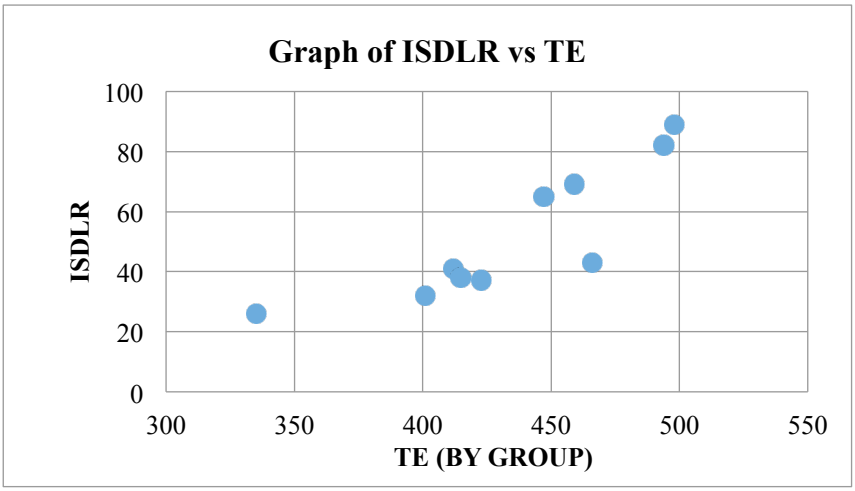


Figure 6: (a) Matrix plot comparison of the measured variables and (b) Graph of ISDLR vs TE on per group basis (n^{group} =10).

Qualitative SPA data in response to the open-ended questions on Team Strengths and Areas for Improvement within the team, are simultaneously collected. With reference to the summary in Table 4, the spectrum of team strengths seems to outweigh the areas for improvements, signifying the effectiveness of the INC instructional program to a certain

extent. The qualitative indicators on per group basis are translated into numerical values for better comparison against the ISDLR and TE trends.

Team Strengths	**Areas for improvements**
Take initiative to update progress in a timely manner	Organisation
Take initiative to clarify matters	Prioritisation of getting things done earlier/meet deadline
Take responsibility to meet deadlines	Punctuality
Listen actively and be open to options	Responsiveness
Provide constructive feedback/ideas	Distraction
Being inquisitive	Confidence to speak up
Exhibit diligence and perseverance to produce quality work	Exploring out of comfort zone
Being cooperative	Conflict management skills
Boost team morale	Optimism
Set team goals	Effective communication
Exercise critical thinking	
Ensure fair in work delegation	
Being organised	
Being creative and meticulous for best quality work	
Establish good team relationships for effective communication	
Being punctual	

Table 4: Reflections of team strengths and areas for improvement within the team.

Reflections	
Student A	"By asking for help, we take ownership of our own learning process, demonstrating the initiative to identify and rectify areas where we might need additional external support or guidance. It required me to be committed and responsible in working together with my team mates on this project by planning ahead of one's schedule and taking up more tasks."
Student B	"I decided to step out of my comfort zone and take up the leadership role to provide team direction."
Student C	"I feel relieved that I have realised this problem of mine (for being too dependent on my team members) sooner. This learning matters as it provided me with impactful insights to how I can understand needs of my group mates and better support them. I would be more proactive and take the initiative for my own learning. "
Student D	"I believe autonomous learning does not only concern oneself, but also influences the progress and learning of those around them, particularly in a group project setting."
Student E	"I learnt that we should be in charge of our own learning and know how to plan our time well for our group mates and for project deadlines. I can use my love for reading to acquire knowledge and share them to my peers when they did not appear to know about the subject matter. During those times, I felt incredibly happy as I was able to help move the project forward."

Table 5: Qualitative evidence of TE-driven SDL.

Additional qualitative evidence from students' reflections (see Table 5) are solicited to augment the TE-driven SDL construct, thereby affirming that the students have demonstrated the ability to take ownership of their learning under positive team influence.

Conclusion

The empirical evidence of this study concurs with the notion of SDLR development through deliberate experiential practices of PBL-DT pedagogical approach. The INC provides a good platform to develop self-directed teams through open-ended industry project challenges. By empowering DPCS students to solve increasingly complex and higher order real-life applications of industry values, a multitude of autonomous learning opportunities are presented in the search and design of feasible solutions. The reinforcement of SDL behaviours in students by capitalising on team influence is a prospective strategy. The development of a collaborative, inclusive and supportive learning environment is posited to encourage sustained interest of students' learning independence. Friedman test at $p < 0.001$ indicates statistically significant outcome in the progressive SDLR increment as students deepened their PBL engagement over time. The relatively high Spearman correlations ($\rho > 0.8$) among the TE and SDLR measures provide additional insights into their positive monotonic relationships. In other words, TE comprising elements of Team Motivation, Team Structure, Team Dynamics and Team Excellence, acts as an enabler to stimulate continual growth in students' SDLR. From a broader perspective, this study targets to fulfil the institutional mission on inculcating SDL skillsets in students, thereby improving their capacity to engage in lifelong learning for their professional advancement.

Acknowledgement

We would like to express our gratitude to Singapore Polytechnic for the steadfast support and provision of essential resources, which have been instrumental in the fruition of this research.

References

Bandura, A. (1977). *Social learning theory.* Prentice-Hall.

Boud, D., Keogh, R., & Walker, D. (1985). Reflection: Turning experience into learning. Abingdon, England: Routledge.

Boyer, S.L., Edmondson, D.R., Artis, A.B. & Fleming, D. (2014). Self-Directed Learning: A Tool for Lifelong Learning. *Journal of Marketing Education,* 36(1), 20–32.

Breed, B. (2016). Exploring a cooperative learning approach to improve self-directed learning in higher education. *Journal for new generation sciences, 14*, 1–21.

Brookfield, S. D. (1985). Self-directed learning: a conceptual and methodological exploration. *Studies in the Education of Adults*, 17(1), 19–32.

Candy, P.C. (1991). *Self-direction for lifelong learning: A comprehensive guide to theory and practice.* Jossey-Bass Publishers. San Francisco, CA.

Fisher M., King J. & Tague, G. (2001). Development of a self-directed learning readiness scale for nursing education. *Nurse Education Today*, 21(7), 516–525.

Freire, P. (1968, 3rd edition 1996). *Pedagogy of the oppressed*, London: Penguin Books.

Garrison, D. R. (1997). Self-directed learning: toward a comprehensive model. *Adult Education Quarterly*, 48(1), 18–33.

Gibbons, M. (2002). *The self-directed learning handbook: Challenging adolescent students to excel*. San Francisco, CA: Jossey-Bass.

Hiemstra, R.P., & Brockett, R.G. (2012). Reframing the Meaning of Self-Directed Learning: An Updated Modeltt. *Adult Education Research Conference, 2012 Conference Proceedings*: Saratoga Springs, NY.

Jaiswal, A., Karabiyik, T., Thomas, P. & Magana, A.J. (2021). Characterizing Team Orientations and Academic Performance in Cooperative Project-Based Learning Environments. *Education Sciences*, 11(9), 520.

Kemp, K., Baxa, D. & Cortes, C. (2022). Exploration of a Collaborative Self-Directed Learning Model in Medical Education. *Medical Science Educator,* 4, 32(1), 195–207.

Knowles, M. S. (1968). Andragogy, not pedagogy. *Adult Learning*, 16(10), 350–352.

Knowles, M. S. (1975). *Self-Directed Learning: A Guide for Students and Teachers*. Association Press, New York, NY.

Kumar, A.P., Omprakash, A. & Mani, P.K.C. (2021). Validation of Internal structure of Self-Directed Learning Readiness Scale among Indian Medical Students using factor analysis and the Structural equation Modelling Approach. *BMC Medical Education*, 21(1), 614.

Laine, Sanna, Myllymäki, Mikko and Hakala, Ismo. (2021). Raising Awareness of Students' Self-Directed Learning Readiness (SDLR). *In B. Csapó, & J. Uhomoibhi (Eds.), CSEDU 2021: Proceedings of the 13th International Conference on Computer Supported Education, vol. 2*, 324–331. SCITEPRESS - Science and Technology Publications.

Lave, J., & Wenger, E. (1991). *Situated learning*. Cambridge: Cambridge University.

London Leadership Academy. *Team Effectiveness Diagnostic*. National Health Service. Retrieved from https://www.cu.edu/sites/default/files/Team_effectiveness_questionnaire.pdf

Long, H.B. (1989). Self-directed learning: merging theory and practice. Self-directed Learning Merging Theory and Practice. In *H. B. Long, Ed., Research Center for Continuing Professional and Higher Education of the University of Oklahoma*, Oklahoma, USA.

Maknuunah, L., Kuswandi, D. & Soepriyanto, Y. (2021). Project-Based Learning Integrated with Design Thinking Approach to Improve Students' Critical Thinking Skill. *Advances in Social Science*, *Education and Humanities Research, vol. 609, Proceedings of the International Conference on Information Technology and Education (ICITE 2021).*

Merriam, S.B. (2001). Andragogy and Self-Directed Learning: Pillars of Adult Learning Theory. *New Directions for Adult and Continuing Education, 2001*, 3–14.

Mezirow, J. (1985). A critical theory of self-directed learning. In S. Brookfield (Ed.), Self-directed learning from theory to practice (pp. 17–30). San Francisco, CA: Jossey-Bass.

Morris, T. (2019). Self-directed learning: A fundamental competence in a rapidly changing world. *International Review of Education*, 65(1), 633–653.

Oyelere, S.S., Olaleye, S.A. & Balogun, O.S. (2021). *Do teamwork experience and self-regulated learning determine the performance of students in an online educational technology course? Education and Information Technologies*, 26, 5311–5335.

Rogers, C. (1969). *Freedom to learn: A view of what education might become* (1st ed.). Charles Merrill.

Rubin, I.M., Plovnik, M.S. & Fry, R.E. (1978). *Task-Oriented Team Development*. McGraw-Hill. New York, NY, USA.

Siemens, G. (2004). Connectivism: A learning theory for the digital age. International Journal of Instructional Technology and Distance Learning. Retrieved on November 12, 2006.

Siemens, G. (2005). *Meaning making, learning, subjectivity*. Retrieved on November 12, 2006, from http://connectivism.ca/blog/2005/12/meaning_making_learning_subjec.html

Tamara, E.T. van Woezik, Jur Jan-Jurjen Koksma, Rob P. B. Reuzel, Debbie C. Jaarsma & Gert Jan van der Wilt (2021). There is more than 'I' in self-directed learning: An exploration of self-directed learning in teams of undergraduate students. Medical Teacher, 43(5), 590–598.

Thabo, Makhalemele & Nel, Mirna. (2021). Investigating the effectiveness of institutional-level support teams at full-service schools in South Africa. *Support for Learning*, 36(5).

Torabi, Nasim, Abdollahi, Bijan, Aslani, Gholamreza & Bahrami, Azar. (2013). A Validation of a Self-directed Learning Readiness Scale Among Preliminary Schoolteachers in Esfahan. *Procedia - Social and Behavioral Sciences*, 83, 995–999.

Torrijo, F.J., Garzón-Roca J., Cobos G. & Eguibar M.Á (2021). Combining Project Based Learning and Cooperative Learning Strategies in a Geotechnical Engineering Course. *Education Sciences,* 11(9), 467.

VanLehn, K. (2011). The Relative Effectiveness of Human Tutoring, Intelligent Tutoring Systems, and Other Tutoring Systems, *Educational Psychologist*, 46(4), 197–221.

Vann, Barry (2006). Learning self-direction in a social and experiential context. *Human Resource Development Quarterly*, 7. 121–130.

Vygotsky, L. S. (1978). *Mind in Society: The Development of Higher Psychological Processes*. Cambridge, MA:Harvard University Press.

Wiley, K. (1983). Effects of a self-directed learning project and preference for structure on self-directed learning readiness. *Nursing Research*, 32(3), 181–185.

Wong, M.F.F. (2020). Development of higher-level intellectual skills through interactive group work: Perspectives between students and educators. *Medical & Clinical Research*, 5, 27.

Contact email: LOW_Bee_Lee@sp.edu.sg